THE LUMINESCENCE OF DIAMOND—III

SIR C. V. RAMAN

1. THE ELECTRONIC EMISSION SPECTRA

AS was remarked in the first article of the series, the emission band at λ4156 discovered by C. Ramaswamy in the year 1930 plays the leading role in the blue luminescence of diamond, while the band at λ5038 studied later by Dr. Nayar and by Miss Mani plays an analogous role in respect of the green luminescence. These bands sharpen when the diamond is held at liquid air temperature and shift to λ4152 and λ5032 respectively. The λ4152 emission also then appears resolved into a doublet, the width and separation of the components varying considerably with the specimen under study. In particular, the doublet is narrow for the diamonds which exhibit the blue luminescence feebly, a circumstance which is favourable for a satisfactory resolution of the associated vibrational spectrum into its discrete components. Absorption

bands are also observed at λ4152 and λ5032 in the spectrum of white light transmitted by the respecfive diamonds, the strength of such absorption varying *pari passu* with the intensity of the corresponding emission. Hence, one is justified in ascribing them to electronic transitions in the crystal lattice. Where there is an apparent lack of correspondence between the strength of the absorption and of the emission, there is evidence for the existence of self-reversal or other cause affecting the emission intensity.

The investigations of Dr. Nayar and of Miss Mani have also shown that λ4152 and λ5032 are by no means the only electronic transitions recorded in the luminescence spectra, though these stand out by reason of their special intensity and their association with vibrational transitions in the lattice. Lines

appearing strongly both in emission and absorption have been observed at λ 4189, 4197, 4206, 4907, 4959 and 5359. A fairly strong line at λ 5758 and numerous others which are less intense have also been recorded in the emission spectra of various diamonds but have not so far been detected in absorption. The electronic emission lines may be divided broadly into two groups, *viz.*, those that appear along with the emission at λ 4152 and the rest with that at λ 5032. They are observed respectively with the diamonds exhibiting these two types of luminescence.

The electronic line at λ 4156 present in the blue luminescence spectrum sharpens and increases in peak intensity when the diamond is cooled down. *Per contra*, it decreases in peak intensity when the diamond is heated up, until finally at 350° C. it merges into a continuous background and ceases to be visible. Its integrated intensity has been investigated by Chandrasekharan and found to remain unaltered over a wide range of temperature. Miss Mani's investigations have shown that the other electronic lines likewise shift towards smaller wave-lengths and sharpen when the diamond is cooled down to liquid air temperature. The shift in wave numbers in the

at λ 1060, and the minor term with an absorption wave-length at λ 1750. The actually observed absorption in the ultra-violet, however, extends further towards greater wave-lengths. Diamonds of the non-luminescent type show a complete cut-off for wave-lengths less than λ 2250, while the best specimens of this class exhibit a complete transparency in the visible and near ultra-violet regions of the spectrum. Diamonds which exhibit luminescence, however, show a different behaviour. When the thickness of the plate is reduced sufficiently, the observed transmission extends down to λ 2250. There is, however, a strong absorption at greater wave-lengths, and indeed with the largest thicknesses, a complete cut-off is observed extending to λ 4152, and feebler absorption bands are noticed at even greater wave-lengths. These features are exhibited in Figs. 1 and 2 taken from a paper by K. G. Ramanathan.

In moderate thicknesses, however, blue-luminescent diamonds transmit wave-lengths greater than λ 3000 quite freely with the exception of certain absorption lines noticed in the region between λ 3500 and λ 3000, and the vibrational bands associated with the λ 4152 electronic transition.
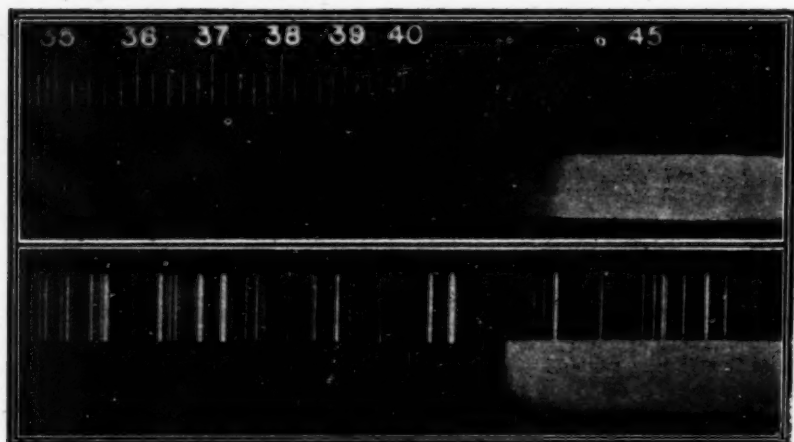

FIG. 1

Absorption of Visible Light by Thick Diamond : (*a*) At Room Temperature; (*b*) At Liquid Air Temperature

various cases is found to be of the same order of magnitude and roughly proportional to the respective frequencies.

2. THE ELECTRONIC ABSORPTION SPECTRA

The refractive indices of diamond fit very well into a dispersion formula containing two terms, the major term indicating an absorption

Some 25 such absorption lines of the first kind can be seen in Fig. 3 which is reproduced from a paper by Dr. Nayar. To record them successfully, it is necessary to hold the diamond at liquid air temperature and to adjust the thickness of diamond traversed as well as the photographic exposure suitably.
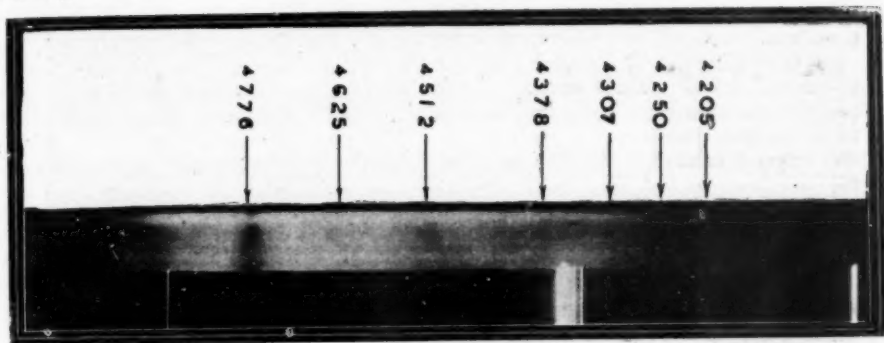
FIG. 2

Absorption of Visible Light by Thick Diamond under High Dispersion.
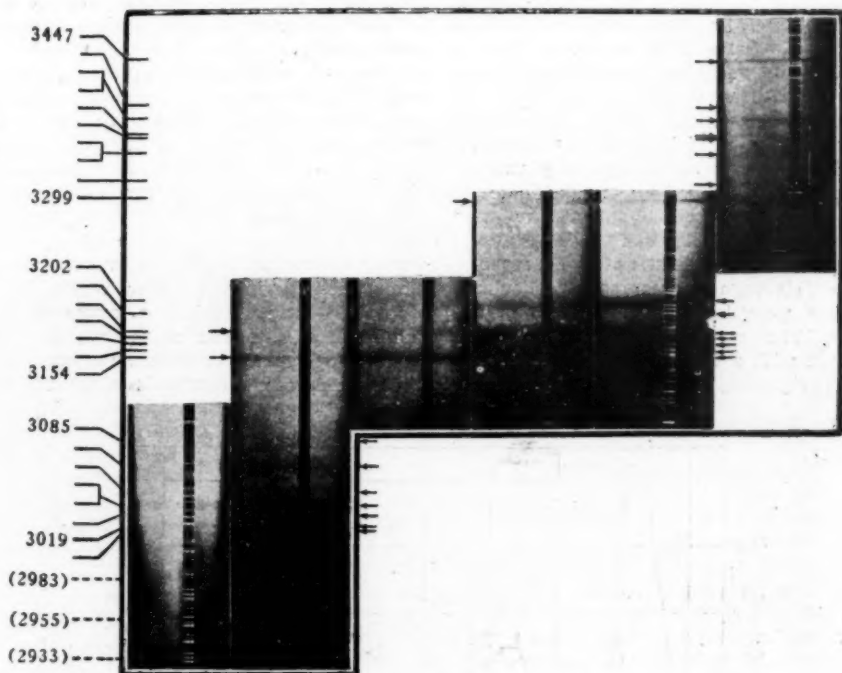
FIG. 3

Absorption Lines in the Ultra-Violet.

Ordinarily, a diamond of the blue-luminescent class should be less than a millimeter thick to show any transmission for wave-lengths less than λ 3000. Very thin diamonds of the same variety exhibit a series of sharply-defined absorption lines in the wave-length region between λ 2370 and λ 2240. These are shown in Fig. 4 reproduced from a paper by K. G. Ramanathan.

It is noteworthy that a precisely similar set of absorption lines is observed also in the ultra-violet transmission of green-luminescent diamond, but can then be seen with moderate thicknesses of the material.

FIG. 4

Ultra-Violet Absorption Spectrum of Thin Blue-Fluorescent Diamond : (*a*) At Room Temperature and (*b*) Liquid Air Temperature.

It should be emphasised that the absorption spectra exhibited in Figs. 3 and 4 stand on a different footing from those mentioned in the preceding section and 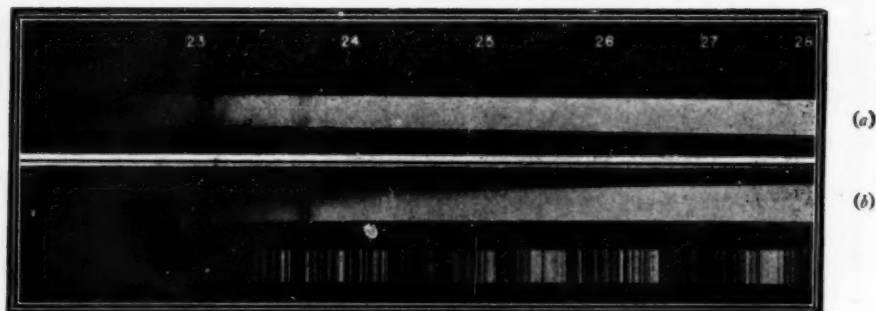those shown in Figs. 1 and 2. They do not appear as emission lines, and their strength is not directly related to the intensity of luminescence. Indeed, the absorption lines seen in the vicinity of λ 3000 become weak and diffuse and the transparency extends further into the ultra-violet in the case of strongly blue–luminescent diamonds, as was first observed by Sunanda Bai.

3. THE INFRA-RED ACTIVITY OF DIAMOND

Polished cleavage plates are particularly suitable for quantitative studies on infra-red absorption. The results obtained by K. G. Ramanathan with a whole series of such plates are highly significant in relation to our pre-

sent subject. No important differences are observed as between different diamonds in the infra-red activity in the spectral region between 1400 and 2800 cm.$^{-1}$ which covers the octaves and combinations of the fundamental vibration frequencies. There are, however, great differences in behaviour in the spectral region between 700 and 1400 cm.$^{-1}$ which covers the first-order vibration frequencies. The diamonds which are non-luminescent are completely transparent in the latter region. On the other hand, the non-birefringent and weakly blue-luminescent diamonds show a strong activity in the latter region, and the absorption–curves exhibit a series of peaks exhibiting a resolution of the vibration spectrum into distinct components (see Fig. 5). Green-luminescent diamonds show an inter-

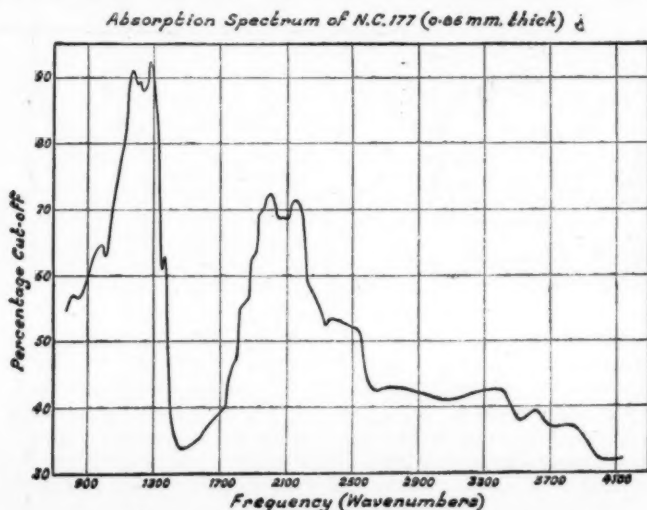*Absorption Spectrum of N.C.177 (0·86 mm. thick)*

FIG. 5

Infra-Red Absorption Spectrum of Blue-Fluorescent Diamond.

mediate behaviour, such as would result from passage successively through two plates of appropriate thickness belonging respectively to the active and non-active types (see Fig. 6). *Strongly* blue–luminescent diamonds are found to exhibit an infra-red activity which is distinctly less than in the case of diamonds with a weak luminescence. The character of the absorption-curve also shows minor variations accompanying the changes in the colour and intensity of the luminescence.

activity indicates that the electronic structure of the non-luminescent diamond has the highest or Oh type of symmetry, while the electronic structure of the blue-luminescent diamonds possesses only the lower or Td type of symmetry.

4. THE ORIGIN OF THE LUMINESCENCE

The experimental facts already described do not permit us to accept the belief formerly entertained that the luminescence of diamond arises from the presence of chemical impuri-

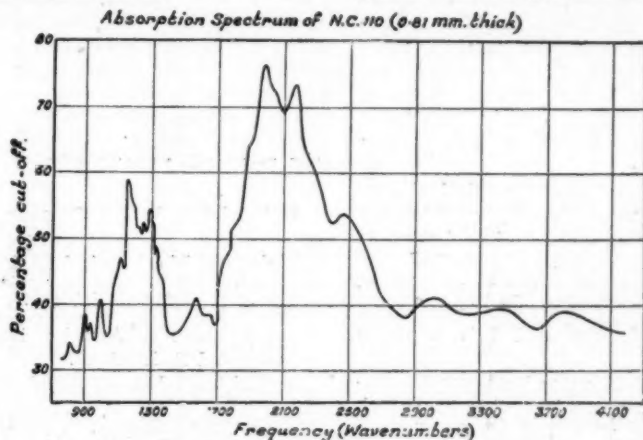Absorption Spectrum of N.C. 110 (0·81 mm. thick)

FIG. 6

Infra-Red Absorption Spectrum of Green-Fluorescent Diamond.

The diamonds which show the first-order infra-red activity most strongly are those which make the nearest approach to ideal perfection of crystal structure as shown by their freedom from birefringence and their X-ray behaviour. *Per contra*, the diamonds which do not show the first-order activity are those which exhibit the largest departure from ideality as indicated by such tests. In these circumstances, it is clearly not possible to ascribe the infra-red activity exhibited by the former class of diamonds to structural imperfections or other accidental circumstances. We are, in fact, compelled to recognize that the difference in behaviour connotes a fundamental difference in crystal structure. The nature of such difference follows from well-established spectroscopic principles, according to which the absence or presence of first-order infra-red activity in a crystal of the cubic class depends on whether the structure of the crystal does or does not possess centres of symmetry. In other words, the observed behaviour in respect of infra-red

ties. They also serve to exclude the alternative hypothesis that the luminescence is activated by extraneous impurities. As early as 1941, Dr. Nayar suggested that the origin of the blue luminescence studied by him should be sought for in the departure of the crystal structure from ideal perfection. While this suggestion contains an element of truth, the results of subsequent investigations with a wider range of material show that it is not by itself sufficient to cover the facts. It does not, for instance, explain why diamonds which, as judged by optical and X-ray tests, show structural imperfections of the crystal in the highest degree, are precisely those which are non-luminescent. Neither does it account for the green type of luminescence and for the relationship between luminescence and birefringence which has been so clearly established. We are thus forced to look a little deeper to reach a clear understanding of the array of facts revealed by the Bangalore investigations.

(To be continued)

DR. M. S. KRISHNAN

SCIENTISTS all over India will welcome the news of the appointment of Dr. M. S. Krishnan, M.A., Ph.D., A.R.C.S., F.N.I., as Director of the Geological Survey of India. Dr. Krishnan is the first Indian to become the Head of this important Department of the Government of India.

Born in 1898 at Maharajpuram, Tanjore District, Dr. Krishnan has had a brilliant academic career. After taking his Honours degree in Geology with distinction from the Madras Presidency College in 1919, he worked as a Demonstrator for two years in the same college. He then went to the Imperial College of Science and Technology, and in 1923, was awarded the Ph.D. degree of the London University.

Dr. Krishnan joined the Geological Survey of India in 1924 as an Assistant Superintendent and did a considerable amount of field work in the Orissa States of Gangpur, Keonjhar, etc. Later, under his direction, many mineral deposits were investigated, and systematic geological mapping commenced in several districts of the Madras Presidency.

From 1933 to 1935, he was Professor of Geology at the Presidency College, Calcutta, which post he held along with that of the Curator (now styled Petrologist) in the Geological Survey.

In 1935, he went to Great Britain, United States of America, and Canada, and visited several important centres of Mining and Geology. On his return in 1936, he was appointed a Member of the Coal Mining Committee constituted by the Government of India.

Dr. Krishnan became a Superintending Geologist in 1945, and in 1946 visited England as an Official Delegate to the Royal Society Empire Scientific Conference. In 1947, he was deputed to Europe and America to make a special study of the methods of investigation of rare earth minerals. In 1949, he attended, at Lake Success, the United Nations Scientific Conference on the Conservation and Utilisation of Resources as a Member of the Indian Delegation.

He was President of the Geology Section of the Indian Science Congress in 1935. He is a Fellow or Member of many learned societies of the world, chief among which are the Indian Academy of Sciences, National Institute of Sciences of India, National Academy of Sciences of India, Mining, Geological and Metallurgical Institute of India, Geological, Mining and Metallurgical Society of India, Indian Society of Soil Science, Indian Ceramic Society, Geological Society of London, American Institute of Mining and Metallurgical Engineers, Canadian Institute of Mining and Metallurgy, Society of Economic Geologists of America, and Mineralogical Societies of America, England, France, Germany and Switzerland.

Dr. Krishnan has published numerous valuable papers on the mineralogy, petrology and economic geology of many parts of India.

The Geological Survey of India has just completed one hundred years of its life, and it is most fitting that at the beginning of the second century, its activities should be guided by such an eminent geologist as Dr. Krishnan who combines wide administrative and organisational experience with intense love for original research. We wish him a very successful tenure of office.

MULTI-PURPOSE FOOD

THE California Institute of Technology has developed a Multi-Purpose Food (M.P.F.) to provide at minimum cost (3 cents) and in minimum bulk (2 oz.) a highly nourishing, palatable, protein food, fortified with vitamins and minerals. The non-profit "Meals for Millions Foundations" introduced M.P.F. to the world and more than 16,000,000 meals have been distributed by relief agencies operating in over 50 countries including India.

Since the Foundation is finding it difficult to export this food freely, it is interested in having a similar type of food developed in India from indigenous materials for use in times of emergency. This Foundation and the Watumull Foundation have accordingly sponsored a research project, in the Food Technology Section of the Indian Institute of Science, Bangalore, for exploring the possibility of utilising the abundantly available oilcakes for this purpose. The nutritive value of the preparations processed in he section will be determined by mass feeding experiments and, compared with that of M.P.F., a ton of which has been donated by the two Foundations.

TOPOLOGICAL METHODS IN ANALYSIS

IN his Presidential Address to the Mathematics Section of the 38th Indian Science Congress, Dr. Racine gave a survey of the methods developed by J. Schauder and J. Leray for the boundary value problems associated with elliptic partial differential equations of the second order. The first linear problems to be studied were those of determining harmonic functions satisfying the boundary conditions of a Dirichlet- or Neumann-problem (D- or N-problem). The D-problem in this case may be solved, under very general conditions, by the method of "balayage" due to H. Poincaré. Such a method has not been adapted so far to the general elliptic equation. By constructing appropriate Green's functions, Giraud established the equivalence of the general D- and N-problems to certain integral equations and thus made available the method of potentials and integral equations as in the classical case of the Laplace equation. Giraud also developed a method of successive approximation for treating non-linear problems. Schauder's method of solution of linear elliptic problems is extremely original and deduces an existence-theorem from an *"a priori approximation"* of the solution. Generally it excludes the possibility of any construction and gives only existence, not uniqueness, theorems. He makes use of refined forms of certain well-known inequalities in the theory of Newtonian potentials and a process of successive approximation starting from the solution for the Laplace equation. Schauder's most important contribution to the theory of partial differential equations of mathematical physics is his new method of solving non-linear problems. His first investigations deal with extensions to function-spaces

of the celebrated "fixed-point-theorem" of L. E. J. Brouwer. There exists an equivalence between a given D-problem and the problem of finding the fixed points of the transformation $u = U(u)$, where U is a functional operator which maps a certain function-space V or a subset of it onto itself. Schauder generalised Brouwer's fixed-point-theorem to topological spaces, but he was obliged to restrict himself to metric vectorial spaces, in particular, Banach spaces. He developed also a second method, based upon his generalisation of Brouwer's theorem on the "invariance of the domain" to Banach spaces in which he defined a weak topology in addition to the strong topology. Leray had utilised a topological invariant: "the degree of a transformation". This notion, due to Brouwer, was generalised to function-spaces by Leray and Schauder, who were thus enabled to develop a general method of proving existence-theorems in the theory of functional equations. The method of Leray and Schauder may be applied to the most general non-linear problems under certain conditions. It has been very successful in the hydrodynamical theories of viscous fluids and of wakes. Recently Leray has developed the theory of a topological invariant attached to the continuous mappings of a topological space into itself. It is valid in compact Hausdorff spaces. His new theory, based essentially on the notion of the "total index" of a transformation with respect to an open set, has enabled him to arrive at a very powerful synthesis of his and Schauder's previous results and to generalise the same considerably.

V. R. T.

GLEEP

THE Graphite Low Energy Experimental Pile (Gleep) at Harwell, was constructed to meet two main requirements: the first was for a pile able to work at as high a power as it is possible without introducing elaborate cooling arrangements. This high power was needed for the production of the radio-active forms of elements which are proving of immense value in many branches of medical and scientific research; the second was to compare, for scientific purposes, the ways in which different elements absorb slow neutrons, the type of atomic particle emitted by the pile.

This relatively small experimental pile requires 12 tons of uranium and a further 21 tons of oxide of uranium. In addition, the pile contains over 500 tons of graphite in a very pure state. It has an output of 100 kilowatts.

By providing radio-active forms of natural elements for research purposes, the *Gleep* has already proved immensely valuable. In addition, the experience gained in operating this experimental pile during the last three years has proved an invaluable aid to the design of larger piles suitable for providing energy on an industrial scale.

—By courtesy to B.I.S.

DOPPLER EFFECT IN LIGHT-SCATTERING*

THE light scattered by all states of matter exhibit a Doppler shift of frequency owing to the thermal motion of the molecules. The effect with gases is readily calculated from the Maxwellian law of distribution of velocities, and the author's experiments on H_2, O_2, N_2 and CO_2 give results in agreement with theory. The diffusion of light by crystals has been studied by Raman and others. In the theory due to Brillouin, it is ascribed to a coherent reflection of light by the elastic waves of thermal origin in the crystal. In general, there are three types of elastic waves in any direction, and two possible velocities for the light waves in the incident and scattered directions, so that 12 pairs of Doppler components should be observable, as was recently pointed out by Chandrasekharan. Gross, Raman and Venkateswaran, and Sibaiya made interferometric studies, while Krishnan and Chandrasekharan have recently recorded the Doppler components with crystals using a three-metre spectrograph.

The molecular scattering of light by liquids was shown by Raman to agree with the Einstein-Smoluchouski formula for density scattering. However, the observations of Gross and of Rao that the scattered light contains Doppler-shifted components called for a revision of the concepts regarding the structure of liquids. The author obtained excellent detail in the patterns by the use of a zinc arc developed by him which emitted radiations free from satellites. It was found that there are (1) a depolarised central component, (2) well-polarised Brillouin components on either side, (3) a diffuse band between the two and (4) a continuous background. These observations are in fair agreement with Frenkel's 'hole theory' of liquids, in which a liquid is supposed to be more akin to a solid than to a gas. The theory however fails to account for the dependence of the intensity of the central component, the continum and the Brillouin components on the viscosity of the liquid.

The hypersonic velocities (i.e., for frequencies of the order of 10^9) in 22 liquids of low viscosity were calculated from the shift of the Brillouin components and showed no appreciable difference from the supersonic velocities. However, in the case of glycerine and castor oil, the hypersonic velocity was far greater than the supersonic velocity. This shows that at high frequencies of the order of 10^{10} sec-1, glycerine behaves like a rigid solid. The relaxation time deduced in this way is in reasonable agreement with that calculated from Maxwell's formula $\tau = \frac{\eta}{n}$. Recently, R. S. Krishnan has been able to record the Doppler components in fused quartz, which may be considered to be a supercooled liquid with a large relaxation time. Comparative studies of light-scattering in solids, liquids and gases will ultimately lead to valuable information regarding the space distribution and orientation as well as the kinetics of molecules in different states of aggregation. In this field of research as in Raman effect, India's contribution has been quite significant.

THE BEARING OF GEOLOGY ON MULTI-PURPOSE PROJECTS*

IT is with a background of geologically young active movements, and sharp regional and seasonal variations in climate, that we have to view the construction of the major multi-purpose projects. The geologist who is well versed with the broader issues of regional tectonics, earthquakes, soil erosion and water conservation must play a major part in the planning of such projects. Thus the occurrence of earthquakes have to be taken into serious consideration.

Earthquakes produce landslips in the mountainous regions. By the determinations, made by the U.S. Coast and Geodetic Survey, of the epicentre of the recent August (1950) Earthquake, it is inferred that the Teesta landslips are related to the effect of an abnormally wet monsoon on hill slopes and not to the Assam Earthquake. But at the same time we have to bear in mind that even the mildest shock of the earthquake acts as a trigger and might initiate slips in loose ground.

The secular changes in elevation of the Himalayas also play an important part in the construction of multi-purpose projects. The slow secular movements which are taking place

in the orogenic zone both vertically and horizontally have yet to be confirmed by instrumental observations.

The study of the dam sites like Dhiangarh, Larji and Daher within the Himalayan region has shown that a number of large projected structures lie close to major thrust planes. In all such cases it is essential to decide to what extent proximity to the major thrust planes is likely to be a dangerous feature affecting the stability of structures. The general impression is that a structure of large dimensions can be designed as a safe unit against major shocks. The Himalayan Valleys, notwithstanding their proximity in certin parts of the range to seismic centres, are permissible locations for the construction of dams.

The Peninsular structures are quite different. The Peninsula has not undergone the recent orogenic movements of the montana zone.

Many of the dam sites have presented foundation defects and these require engineering treatment. The main feature with which we are concerned happen to be weathering and the consequences of faulting and shearing.

The generalised text-book statements that the strike of the bedded rocks should be parallel to the axis of the dam must not be mechanically and uncritically followed. On the other hand, studies of the Indian dam sites have clearly shown that each dam has to be judged on its own merits. Also we have to bear in mind that geological terrains can be radically different, and that all projects must be assessed by a comprehensive study of tectonics, seismicity, siltation and economics. Our conclusions must not be based merely on problems solved elsewhere as they may not serve the best interests of our country.

M. G. C. NAIDU.

CHEMOTHERAPY OF MALARIA—A FUNDAMENTAL APPROACH

CONTROL of malaria by prophylaxis and by chemotherapy has so far been our stumbling block. No satisfactory prophylactic drug has yet been announced and the so-called curative drugs have been found to be ineffective even under optimum conditions in all species of malaria. Great advances have recently been made and the discovery of the exo-erythrocytic forms in the liver of the primates and humans should be a great help in the experimental approach of the problem. But our chief difficulty in the interpretation of the anti-malarial toxicological data lies in the lack of precise knowledge as to the actual site of drug interaction in the parasite. If we could determine the relationship between the drug receptor group in the parasite and the external drug phase, we would be in a much better position than we are at present to collaborate with the chemists in the synthesis of new and effective compounds.

It is with this end in view, study in the physiology and biochemistry of the malarial parasites, both *in vivo* and *in vitro*, is being carried out in the Pharmacology Laboratory at the Indian Institute of Science, Bangalore.

The present knowledge of the nutritional requirements of malaria parasite, its respiratory system, and enzyme make-up is very meagre. Some progress in the direction of *in vitro* culture of the forms of malaria parasite characteristic of infection in vertebrate host has been made in this laboratory with relatively crude cultures and attempts are being made at a fine analysis of the basic nutritional need of *P. gallinaceum*. Correlating all these data, it is the aim of the laboratory to find new chemotherapeutic agents for malaria by testing analogues of metabolites essential for blood forms.

Nutritional studies of blood forms of malaria parasites *in vitro* will alone not solve the problem. Cultures of exo-erythrocytic forms are perhaps more likely to provide more information than the culture of blood forms in nutritional studies designed to lead towards curative anti-malarials, but precise analysis of the parasites' nutritional requirements in their complex extra-cellular environment would present very great difficulty. Attempts are also being made in this direction because the cardinal requirement of anti-malarial chemotherapy is to find a substance which would attack the parasite in its exo-erythrocytic form.

LETTERS TO THE EDITOR

UNIT CELL AND SPACE-GROUP OF SODIUM TARTRATE $Na_2C_4H_4O_6$, $2H_2O$

SODIUM TARTRATE was crystallised from aqueous solution at room temperature. The crystals, belonging to the orthorhombic system (point-group 222), were needle-shaped, being elongated along the c-axis. Rotation photographs taken about the a-, b- and c-axes yielded the following values for the unit cell dimensions: $a = 11.5$ Å, $b = 14.7$ Å, $c = 4.95$ Å. From high order reflections in the zero-level Weissenberg patterns about the c- and b-axes, the unit translations were found more accurately to be

$a = 11.49$ Å, $b = 14.67$ Å $c = 4.97$ Å

The ratio $a : b : c$ works out to be $0.782 : 1 : 0.338$ agreeing well with the values $0.779 : 1 : 0.335$ deduced from morphological studies quoted by Groth.[1] Assuming the density to be 1.818,[2] the number of molecules in the unit cell is calculated to be 3.986, i.e., $Z = 4$.

Zero-level Weissenberg patterns about c- and b- axes showed the following extinctions: orders $h00$, $0k0$, $00l$ are absent if h, k, l are odd respectively. The orthorhombic space-group $P2_12_12_1$ is thus the only possibility, which is compatible with the point-group 222 deduced from the external form.

(MRS.) AHALYA RADHAKRISHNAN.
G. N. RAMACHANDRAN.
Department of Physics,
Indian Institute of Science,
Bangalore-3,
January 12, 1951.

1. Groth, P., *Chemische Krystallographie*, 3, 332.
2. Lange, A., *Handbook of Chemistry*, V Edn., 1944, 244.

TESTING IMAGINATION BY PROJECTIVE TECHNIQUE

USE of Ink-blots has of late become widely popular as an effective means of clinical and normal personality diagnosis. . The type that is commonly employed, however, is the passive interpretative, viz., inviting the testee to 'see' ideas in the given blot. The Psychological Laboratory of the Indian Institute of Science, Bangalore, experimented upon variant types, the purpose being to get at the most effective type. Out of one hundred chance blots, five blots were selected by process of standardisation; those blots were manipulated by way of

taking out a large part from each blot and of denuding the blots of their colour; the former were called Part-blots; and the latter Empty-blots. The original blots were whole-filled. These were also emptied of their colour. Thus four varieties of blots, *viz.*, whole-filled (WF), whole-empty (WE), part-filled (PF), and part-empty (PE), were administered in two ways, passive interpretation (I) and active projection (P). The former is the familiar way of asking the subject to note down what ideas occurred to him as a consequence of attending to the blot. The latter was the new technique of asking the subject to create ideas on the basis of the given part blots, either whole or empty, manipulating the blot by addition of lines, dots, shades, etc. A difference was thus introduced in the structuredness of the field of perception. Thus a series of six types was obtained: WFI, WEI, PFI, PEI, PFP and PEP.

The purpose of the study was to determine the precise role of the various ways of structuring the blot that plays in occasioning imagination.

For a preliminary study, ten adolescent males of the High School Standard, their ages ranging between 14 and 18 years, were chosen at random and 400 observations were made at different intervals in order to minimise the lag effect, and the number of responses in each case within the specified time (5 min) were recorded. The scores were statistically treated by the analysis of variance method. The variance between the responses was found to be highly significant, indicating thereby that the null hypothesis (*viz.*, the various methods of utilizing the blot-material have the same influence over the subject in so far as the number of interpretation within a given time is concerned) is probably untrue. The variation in the number of responses arises from certain significant variations in the responses themselves. The critical difference in the totals of the responses was calculated to be 27·096: and it was dicovered that the responses involving projective technique, in no case, exceeded *in number* those not involving projective technique. But this conclusion is tentative and subject to confirmation by a wider sample.

Out of the several modes, WEI seems most fruitful; WF in both I and P are significantly inferior to WE. Among the part blots, PFI seems to be the best and its superiority over PEP and PFP is significant, but not over PEI. In effect, whole-empty appears the best in occasioning imagination out of the six modes,

taking into consideration the quantitative aspect of responses only.

Sec. of Social Sciences,   N. S. N. SASTRY.
Indian Inst. of Science,   S. K. R. RAO.
Bangalore,
January 17, 1951.

"PARTITION PHOSPHORUS" IN BLOOD OF CHICKS DURING INFECTION WITH *P. GALLINACEUM*

BOVARNICK, *et al.*[1] during their study on the metabolism of *P. lophuræ* reported that the analyses of changes in total labile and inorganic phosphorus in parasite reaction mixtures under various conditions indicate that 100 minute incubation in buffer without substrate leads to an increase in the inorganic phosphorus and to decrease in organic and labile phosphorus. Significant increase has also been observed to occur in nucleic acid P, phospholipid P and 15-minute acid hydrolysable P in red blood cells during the growth of *P. knowlesi* in monkeys.[2,3]

In an attempt to study the metabolism of the malarial parasites, investigations into certain chemical and metabolic properties of blood of normal and infected hosts were undertaken. In this note report is only made of the changes in various forms of phosphorus occurring in the blood of chicks infected with *P. gallinaceum.* During the course of investigations the phosphorus content of the blood of the chicks was noted to be much greater than that of mammals, the inorganic phosphorus comprising only a small fraction of the whole.

Experimental:—Blood from donor chicks was drawn by cardiac puncture and diluted with 2% citrated saline so that 0·1 ml. contained approximately 10^6 parasitised red blood cells. Inoculations with infected blood were made intramuscularly and the course of infection was followed by taking blood smears regularly and staining with Leishmann stain. Parasite counts are expressed as percentage by actually counting the number of parasitised cells in 500 r.b.c.

The estimations of partition phosphorus are carried out by methods described by King.[4] Only in the case of ester phosphorus the method was slightly modified, thus: 0·5 ml. of blood was added dropwise with shaking to 5 ml. of a mixture of 90 parts of alcohol and 10 parts of ether in a pyrex tube marked at 10 ml. The mixture was refluxed on a water-bath for 10 min., cooled and made up to 10 ml. The mixture was filtered as quickly as possible. 5 ml. of the filtrate was carefully evaporated to dry-

Period		Before infection	Pre-patent period	< 5% parasitemia	10-15% parasitemia	>20% parasitemia
Total P	..	101·8 ±3·2 mg./100 ml.	91·2 mg./100 ml.	80·8 mg./100 ml.	73·8 mg./100 ml.	73·3 mg./100 ml.
Ester P	..	31·35±2·5 ,,	28·3 ,,	20·2 ,,	17·5 ,,	18·3 ,,
Inorg. P	..	4·7 ±0·27 ,,	4·3 ,,	4·4 ,,	5·4 ,,	5·5 ,,
Lipo. P	..	18·0 ±0·92 ,,	12·4 ,,	16·9 ,,	17·8 ,,	17·7 ,,

ness. The phosphate was estimated by digestion with perchloric acid as in the case of total acid soluble P. The experiments were conducted on 12 white leg-horn chicks, 3-4 weeks old. The analyses were done in duplicate and the results obtained are given in the above table.

As the period of infection lengthened there was a steady decrease in the total P. It was significant that the phospholipid attained a very low value during the prepatent period and increased again almost to the normal value with the appearance of the parasites in the blood stream. The lowering of the total P during infection is seen to be mainly due to the decrease in organic bound P. Reduction in the number of cells alone does not explain fully the decrease in ester P. Presumably the metabolism of the parasite is also intimately involved.

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STUDIES IN ION EXCHANGE.

Part I. Equilibrium Studies of Three Synthetic Cation Exchange Resins

THE three synthetic cation exchange resins used were Amberlite IR-100, Amberlite IR-105 and Amberlite IR-120, manufactured by Resinous Products Division, Rohm and Haas Co., Philadelphia, Pa.

Equilibrium studies, from the point of view of constructing the pH — m.eq. cation uptake/gm. air-dried resin-titration curves[1] and determining the available replaceable hydrogen have been reported for Amberlite IR-100[2-4] and Amberlite IR-105.[5] However, to our knowledge, no such studies are available for Amberlite IR-120. Hence we have carried out such studies for all the three resins under similar conditions. The resins were used in the air-dried hydrogen form.

Figs. 1 and 2 give the pH titration curves for Amberlite IR-100 and Amberlite IR-105,
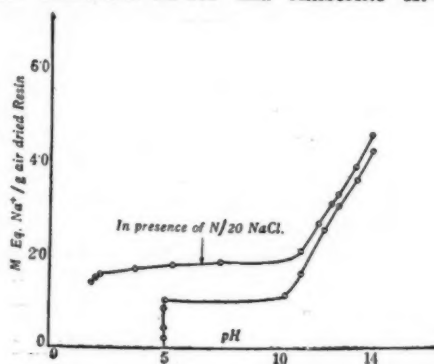
FIG. 1. Titration Curves of Resin Amberlite IR-100 H
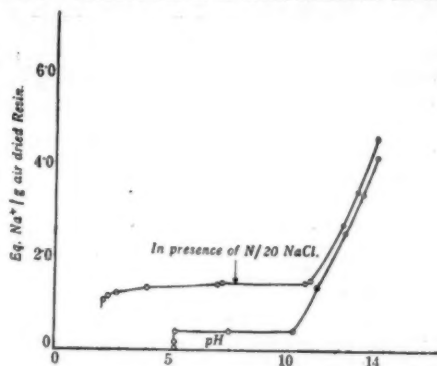
FIG. 2. Titration Curves of Amberlite IR-105 H.

respectively in the presence and absence of N/20 sodium chloride. The curves indicate that up to pH 10-10·5 the active groups are of sulphonic type and above this, groups of hydroxyl type are also active. Fig. 3 shows the pH titration curves for Amberlite IR-120, with and without N/20 sodium chloride. From the curves, it can be concluded that in the presence of salt, the resin is truly unifunctional, the ion active groups being of sulphonic type. But, in the absence of salt, the activity of all these groups is not the same.

The pH titration curves for the three resins

In presence of N/20 NaCl.

M. Eq. Na⁺ / g air dried Resin

pH
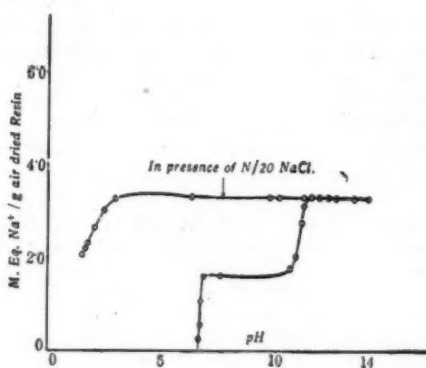
FIG. 3. Titration Curves of Amberlite IR-120 H.

also show that the excess of cation (here Na⁺)
increases the cation uptake of the resin at the
same pH, which should be due to increased
$\frac{Na^+}{H}$ ratio, according to the Mass Action Law.

The available replacable hydrogen was de-
termined by the following methods:—

(a) pH — m.eq. cation uptake per gm. air-
dried resin-titration curve (at pH 6-7).

(b) Limiting exchange value with BaCl₂
solution.²

(c) Ash determination in barium salt of the
resin.²

Table I give the results obtained.

TABLE I

Resin	Moisture content of air dried resin in hydrogen form	10¹ × m.eq. available replacable hydrogen per gm. fully dried resin by method		
		(a)	(b)	(c)
Amberlite IR-100	21·1%	1·71	1·55	1·67
Amberite IR-105	29·2%	2·30	2·62	2·60
Amberlite IR-120	28·0%	4·58	4·62	4·63

Further work is in progress, and will be
published shortly elsewhere.

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IONOPHORETIC SEPARATION
OF METHIONINE

ALTHOUGH the dl form of this amino acid has
been prepared synthetically and has been shown
to have the same physiological activity as the
natural isomer, numerous investigations have
been carried out to isolate it from protein hy-
drolysates.[1,2,3] Unfortunately, however, none of
the isolation methods employed optimum con-
ditions given by Toennis and Kolb,[4] for the
complete precipitation of methionine.   This
precipitation has been found to be usually
complete in the absence of chloride ions, the
dicarboxylic and diamino acids, at a neutral pH
and in the presence of a'cohol.   It occurred to
us, therefore, that these conditions could best
be fulfilled by adoption of the ionophoretic
procedure for protein hydrolysates, whereby all
inorganic ions as well as the dicarboxylic and
diamino acids could be separated from methio-
nine.   It was expected from theoretical consi-
derations that methionine would behave as a
perfectly neutral amino acid and remain in the
central compartment of the three compartment
ionophoretic assembly, even though Block[5] has
observed that this amino acid is to be found
in the anode chamber.   Hence ionophoretic
separation of methionine from protein hydroly-
sates was attempted in the following experi-
ments.

Fibrin and casein with an average methio-
nine content of 2·5 and 3·1 per cent. respec-
tively have been employed in these studies. For
methionine estimations. the colorimetric method
of Sullivan and McCarthy,[6] as modified by
Horn, Jones and Blum.[7] was found to yield
consistent and reproducible values. The amino
acid mixture recommended in the method was,
however, omitted, but this did not affect in-
tensity of colour or proportionality as measured
with the Lumetron photo-electric colorimeter.

100 g. of fibrin (82·15 g. when corrected for
moisture and ash), was hydrolyzed with 500 ml.
of 25 per cent. (v/v) sulphuric acid for 24
hours.   The hydrolysate was neutralised by
addition of 177 g. of solid calcium oxide and the
precipitate filtered and thoroughly washed.
The combined filtrates; which were reduced to
a volume of 600 ml. in vacuo, was adjusted to
pH 7·5 with sodium hydroxide and placed in
the centre compartment of the three compart-
ment cell of Cox, King and Berg.[8] The two
side compartments contained distilled water, the
electrodes being then connected to a 220 volt
D.C. main and a suitable resistance inserted to
give a current of 0·5 amperes.   At the end of

24 hours, the anolyte on testing did not indicate the presence of methionine. The ionophoretic transport was allowed to go on for 168 hours, at the end of which period, the centre compartment was practically free from the diamino acids, as indicated by the absence of turbidity with a solution of 5 per cent. phosphotungstic acid in 2N sulphuric acid. The anolyte did not answer the test for methionine even at the end of this period. The liquid in the central compartment was processed for methionine following the directions of Toennis and Kolb,[4] and 104 mg. of methionine of 96 per cent. purity as determined colorimetrically was isolated. It was further observed that only 60 per cent. of the methionine present in the fibrin originally was accounted for in the analysis of the liquid in the central compartment. As the anolyte did not contain any methionine, it was thought that migration of methionine to the kathode cell might have taken place to a certain exent. This was found to be so in experiments carried out with casein hydrolysate.

250 g. of light white soluble B.D.H. casein (N — 15·75% Moisture — 10·24% and ash — 3·33%) was hydrolysed with 1750 ml. of 20% HCl. for 20 hours. The hydrolysate was freed of humin and the excess HCl. was removed by distillation *in vacuo*. The pH was finally adjusted to 7·5 and the hydrolysate was transferred to the centre compartment of the cell. At the end of 24 hours, the liquid in the end compartments was removed and replaced with distilled water; this process was repeated at the end of 48 hours, 120 hours and 264 hours respectively. The centre compartment at the end of the experiment was found to be free of all diamino acids. The anolyte did not answer the test for methionine throughout the duration of the experiment. The methionine contents of the various catholyte fractions and the final methionine content of the liquid remaining in the centre compartment are given in the accompanying Table.

Methionine Content of Various Fractions

Duration of dialysis	Methionine content of anolyte	Methionine content of catholyte	Methionine content of centre comp. liquid
Hours	mg.	mg	mg.
24	nil	301·6	..
48	nil	262·5	..
120	nil	308·8	..
264	nil	490·8	1,746
Total ..	nil	1,363·7	1,746

It is evident from these observations, that under the conditions of ionophoresis employed in these experiments, appreciable amounts of methionine migrate to and are to be found in the catholyte fractions. Since the anolyte fractions both in the case of fibrin and in the case of casein gave a negative test for methionine, there appears to be no migration of this amino acid to the anode contrary to the findings of Block.[5] It may be that the migration of the methionine is dependent on the sum total of the effects of physical and chemical forces during ionophoresis and the charged nature of the amino acid. However, the establishment of conditions under which all the acidic and basic amino acids will be removed, allowing only the methionine to remain in the centre chamber, would make ionophoretic separation of methionine an excellent technique for methionine preparation, particularly since such a procedure allows the simultaneous preparation of many other amino acids from the same protein. Expensive reagents usually used for effecting such a separation of amino acids are thereby avoided and the ionophoretic method should, therefore, prove useful in the commercial preparation of amino acids from easily available and cheap protein sources of fish meal or slaughter-house blood.

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EFFECT OF AUTOCLAVING ON THE NUTRITIVE VALUE OF BENGAL GRAM, DHAL ARHAR AND LENTIL

THREE pulses—Bengal gram (*Cicer arietinum*), Dhal Arhar (*Cajanus indicus*) and Masur Dhal (*Lentil-lens esculenta*) were compared for their nutritive value. The flour was evenly spread on enamelled trays and autoclaved for 15 minutes at 15 lb. P.S.I. Twenty-four 4-week old, albino rats were evenly distributed into six groups and kept in individual cages. The initial weights of the rats kept on Bengal gram and Dhal Arhar diets were about 36 g. whereas

rats on Masur dhal diets weighed 37 g. Two male and one female rats were used for study with each diet. They were weighed once a week for four weeks and a record of the daily food intake of each rat was also kept. The level of the protein of all the diets was 12 per cent. Table I gives the composition of the diets.

TABLE I

Composition of the diets

		*Bengal gram	*Dhal Arhar
Pulse flour	..	54	59
Starch	..	32	27
Salt mixture[5]	..	4	4
Hydrogenated fat	..	9	9
Shark liver oil	..	1	1

* Adequate quantity of B-complex vitamins and Choline chloride were added to each diet.

TABLE II

Effect of autoclaving pulses on the growth and food consumption of rats

		Bengal gram		Dhal Arhar	
		Raw	Aut.	Raw	Aut.
Gain in weight per rat per week g.	..	5·6	14·7	11·8	8·3
Standard Deviation	..	0·35	1·73	5·94	2·64
Standard Error	..	1·05		3·67	
Protein consumed g. per rat per week	..	4·76	6·14	5·65	4·97
Gain in weight/Protein consumed	..	1·17	2·40	2·11	1·66

Table II shows that the growth of rats on autoclaved Bengal gram diet was better than that on the raw Bengal gram diet. But the rats fed on raw Dhal Arhar diet gained more weight than those on autoclaved Dhal Arhar diet. The results have been treated statistically and it is found that the difference between the means in the case of Bengal gram diet is significant; whereas in the case of Dhal Arhar, it is insignificant.

In the case of Masur Dhal, however, no difference in growth was observed on the raw and autoclaved diets.

Borchers *et al.*[1,2,3] have shown the presence of a trypsin inhibitor in *Cicer arietinum*, to the extent of 32·3 inhibitor units whereas *lens esculenta* contained only 6 Inhibitor units. They have further shown that about 80 per cent. of the inhibitor was destroyed by

autoclaving the soybean meal at 15 lb. for 15 minutes and that there was no inhibitor present after 20 minutes.[4] Thus, autoclaving Bengal gram for 15 minutes, has possibly destroyed the trypsin inhibitor and increased its nutritive value.

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VITAMIN B₁₂ IN INFANTILE CIRRHOSIS

THE initial interest in Vitamin B_{12} as an important anti-anæmic factor has to some extent tended to overshadow other possible physiological effects and clinical applications of this vitamin. The discovery that it is a growth promoting animal protein factor[1,2] led to its trial in improving the development of children with growth failure.[3] Inasmuch as B_{12} has been shown to play an important role in liver physiology, another possible application is its use in protection against liver injury. This may be of particular interest in India where the condition popularly known as "Infantile Biliary Cirrhosis" (better referred to as Infantile Cirrhosis since pathological studies do not support its biliary distribution) is a very common and highly fatal condition.

Our suspicion that Vitamin B_{12} might be of value in infantile cirrhosis of the liver was based on the supposition that this condition was nutritional in origin and that this substance, which is both an important liver constituent and an animal protein factor, was probably deficient in the low protein, predominantly vegetarian diets which are common in these areas. Recently evidence has accumulated which helps to elucidate the important role of Vitamin B_{12} in liver physiology, including its possible usefulness in protecting against liver injury. Close relationships to amino acid metabolism[4] and to other protective substances such as choline, and methionine[5,6,7] have been demonstrated. B_{12} has been found to assist in maintaining the basophilia of the liver cells[8] and to inhibit the development of certain chemical and histological changes, especially fatty metamorphosis, following carbon tetrachloride intoxica-

tion[9,10] in rats. Drill and McCormick observed that a B_{12} concentrate exerted a marked lipotrophic effect when injected into rats receiving a high fat diet[11] though they were unable to show this effect with crystalline B_{12}[12] Enlarged livers have been found in B_{12} deficie..t animals.[7,13] Gyorgy and Rose[14] reported that B_{12} showed significant lipotrophic activity in rats fed on a low protein low fat diet though it did not protect against massive hepatic necrosis.

Dinning, et al.[15] found that B_{12} increased the liver choline oxidase activity in rats on diets containing pyridine; and they as well as Gillis and Norris[16,17] suggested that B_{12} is concerned in transmethylation mechanisms. Jukes, et al.,[18] Stockhead, et al.,[19] Oginsky[20] and Ste'cal et al.[21] obtained evidence indicating that B_{12} can promote methylation of homocystine or homocysteine to form methionine, which is known to be protective against both massive necrosis and cirrhosis[22] Though homocystine is probably not a normal dietary constituent, these experiments appear to indicate that B_{12} plays a role in the important transmethylation mechanisms of the liver. However, it was noted[18,21] that deficient animals grew more rapidly when B_{12} was supplied in addition to methionine, indicating that its function is not confined to formation of methionine.

To date Vitamin B_{12} has been used in seven cases of 'infantile cirrhosis' for periods up to five months. In several of these there were family histories of deaths from infantile cirrhosis and of previous attempts at treatment, including use of the popular commercial preparation of unknown composition called "Jammi's Livercure". In all cases the liver was markedly enlarged and two cases had progressed to the stage where the abdominal veins were prominent and engorged. Detailed case reports will be published later, but we feel the results have been sufficiently encouraging to warrant this preliminary note. Usually treatment resulted in prompt improvement in the child's general condition, followed by gradual softening and decrease in size of the liver, though in no instance has the liver yet regressed to the point where it is no longer palpable.

Since several of these cases were treated in rural areas and none was hospitalized, little biochemical or hematological study and no liver biopsies were possible. We realise that evaluation of results on clinical grounds alone is extremely risky. Convincing evidence of the value of B_{12} in this condition must await further studies under controlled conditions and must include adequate biochemical and pathological studies. Such studies are in progress but we believe the results thus far obtained justify calling the possibilities of this therapy to the attention of biochemists, physiologists and clinicians who may be interested in this problem. Further work will be necessary to determine whether the apparent improvement noted in these cases will continue, whether treatment with other nutrients in addition to B_{12} is indicated, and whether the effect of B_{12} on the liver, if any, is due to a specific influence on liver pathology or merely to a general nutritional improvement in children suffering from a nutritional deficiency.

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BORAX AS A NEW CONDENSING AGENT FOR THE PREPARATION OF CHALKONES

CONDENSING agents like hydrochloric acid, alkalis or phosphorus oxychloride are generally used for the preparation of chalkones from aromatic ketones and aldehydes. It is now found that refluxing the mixture of the ketone

and the aldehyde directly or dissolved in alcohol or acetone with an aqueous solution of borax for three to four hours leads to the formation of chalkones. As with hot alkali, the reaction goes further and flavanones are obtained. To illustrate the procedure employed, the reaction product from acetophenone (5 c.c.), benzaldehyde (4 c.c.) and borax (5 g.) in 25-30 c.c. of water, is steam distilled to remove the unchanged substances and on cooling, the chalkone (1 g.) slowly separates. In the case of resacetophe.:one and benzaldehyde, 7-hydroxy-flavanone that is formed is deposited after keeping overnight.

Thus chalkones have been prepared from acetophenone and *m*-nitroacetophenone, using benzaldehyde, salicylaldehyde and *m*-nitrobenzaldehyde; from acetophenone and *m*-methoxybenzaldehyde and piperonal; from resacetophenone and benzaldehyde and from 2 : 4-dimethoxy-acetophenone and benzaldehyde and o-methoxybenzaldehyde.

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PAPYROGRAPHIC MICROMETHOD FOR THE STUDY OF ORGANIC ACIDS IN PLANTS

STUDIES on the metabolism of organic acids in plants have not rapidly advanced, mainly because of the inherent difficulties encountered in determining small quantities of these metabolites in presence of one another.

Papyrography—partition chromatography on filter-paper—has been used by Lugg and Overell[3] while a micromethod for quantities of the order of 10γ has been developed by Govindarajan and Sreenivasaya[2] for the separation and identification of nonvolatile fatty acids. In view of the simplicity, elegance and rapidity which characterise the technique and of its applicability to the small quantities (25 to 50 mgm.) of research materials, this method should prove attractive and useful to plant physiologists interested in a study of the organic acid make-up of tissues and tissue fluids.

The technique has been fully described earlier.[2] By way of illustrating the adaptability of the method we have analysed the acid-alcohol extracts (processed in a Waring

blendor) of the mature leaves of tamarind (*Tamarindus indica* Linn.) and the leaves and stems of *Oxalis corniculata* Linn. The figure (Fig. 1) shows that the mature leaves of
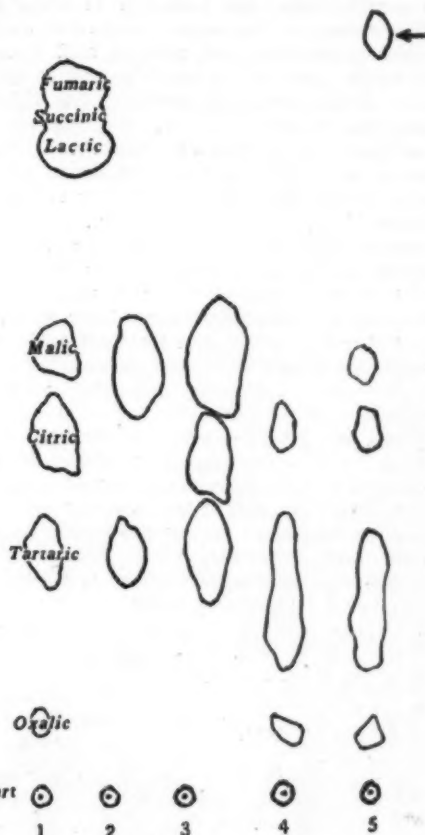
1. Reference Solution—10γ each of pure organic acids
2. Tamarind Leaf Extract—0·01 ml.
3. Tamarind Leaf Extract (0·01 ml.) + Reference Solution (10γ of each acid).
4. Leaves of Extract of *Oxalis corniculata*—0·01 ml.
5. Ext act of Stems of *Oxalis corniculata*—0·01 ml.
Arrow points to unidentified acid with Rf value 0·9.

tamarind contains tartaric acid and a larger amount of malic acid (possibly as their salts). Citric acid is absent. The papyrogram developed with a spot of a mixture of the leaf extract and the reference solution of pure acids, confirms the above finding since the tartaric and malic acid spots are bigger in size while the citric acid spot remains nearly the same as compared to the papyrogram of the spot of the

reference solution identical in amounts to that present in the mixture.

The papyrogram of the extracts of leaf and stem of *Oxalis corniculata* Linn., reveals the presence of large amounts of tartaric acid and a comparatively small amount of citric acid. The extract of the stem shows besides, the presence of malic and another acid with an R_f value (Ratio of excursion of spot to excursion of mobile solvent front) of 0·9 which is awaiting identification. In all these extracts the presence of traces of oxalic acid is also suspected because of the presence of the spot near the starting line but this has to be confirmed since the anions added for liberating the organic acids from their salts, also occupy nearly the same positions on the papyrogram.

A singular merit of this method is that the extracts could be directly used for separation and characterisation of the organic acids, since their excursions are generally unaffected by the other constituents, associated with the extract.

The spots of the papyrogram could be excised from another papyrogram developed simultaneously by reference to an indicator sprayed strip, the individual acids extracted separately and determined quantitatively by specific micro-methods.

Our grateful thanks are due to Prof. M. S. Thacker for his kind interest.

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SULPHANILYL BENZAMIDE AND SULPHANILAMIDE: A COMPARATIVE STUDY ON CHRONIC TOXICITY

THE immature mice used as test animals for this study were from the same colony and littermates, weighing 10 to 12 gms. each. They were sorted into groups of 6 each so that group weights were mostly equal or differed by less than a gm. only. The drug was mixed with stock diet which consisted of oats, wheat bran, bread and milk. The animals were observed for 15 days under such drug-diet. Group weights were recorded every alternate day for 2 weeks. The experiments were performed simultaneously to eliminate variation due to environmental conditions.

TABLE I

Drug	Percentage of drug in diet	Group No.	Group wt. initial	Group wt. in gs. on days during drug-diet							Increase
				1	3	5	7	9	11	15	
Sulphanilyl benzamide	0·25	A	68	68	..	78	83	71	79	84	16
	1·0	B	58	58	68	70	73	77	79	86	28
	1·0	C	69	69	71	..	77	84	92	98	29
	2·0	D	62	62	65	..	72	76	80	86	24
Sulphanilamide	0·25	E	69	69	..	78	80	85	90	96	27
	1·0	F	58	58	64	69	74	77	80	82	24
	1·0	G	69	69	73	..	73	77	81	84	15
	2·0	H	62	62	63	..	64	69	78	85	23
Control (without drug)		I	64	64	74	..	81	..	85	91	27

From the table it appears that sulphanilyl-benzamide is a well-tolerated drug,[1,2,3,4,5] having no significant effect on the progress of normal growth rate of immature mice and appears superior to sulphanilamide for all the dosages used. At 2 per cent. drug-diet both exert a small insignificant depression in the growth rate. The unusual depression with the lowest dose of 0·25 mg. per cent. in the case of sulphanilyl-benzamide can only be explained on the basis of random sampling, since, higher dosages used did not confirm such depression.

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THE EMBRYO-SAC OF *FLOERKEA PROSERPINACOIDES* WILLD.

OF the two genera of the family Limnanthaceæ, *Limnanthes* has been studied by Stenar (1925), Eysel (1937), Fagerlind (1939) and Mason (1949), although without much agreement between any of them. So far there has been no work on *Flœrkea* and the present study is based on a collection of *F. proserpinacoides* made by one of us (P.M.) from Wisconsin during 1946.

Wall cells are absent in the nucellus and there is a many-celled archesporium (Fig. 1).

One or two of the hypodermal cells function as megaspore mother cells. The laterally situated cells of the nucellus also enlarge considerably but are ultimately consumed by the enlarging embryosac.
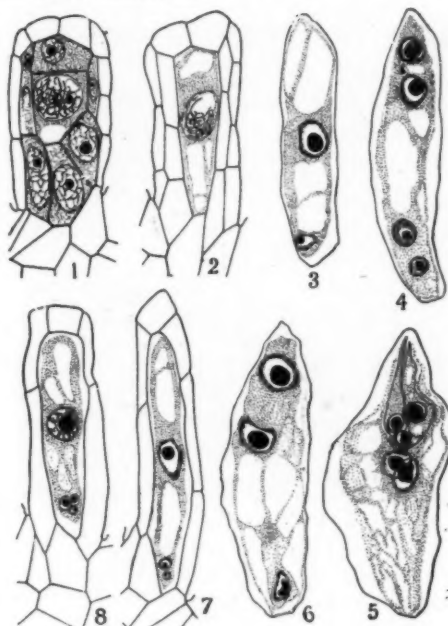
FIGS. 1-8. Development of the embryo-sac; for explanation see text, × 629.

Unlike other plants the megaspore mother cell shows large vacuoles (Fig. 2). The two daughter nuclei formed after Meiosis I are not separated by a wall. The lower of these is always appreciably smaller and moves down to the chalazal end of the cell whereas the upper and larger nucleus lies in the middle of the cell (Fig. 3). Both the nuclei divide and give rise to a four-nucleate stage (Fig. 4). The two micropylar nuclei of the four-nucleate stage divide once and give rise to the egg apparatus and the upper polar nucleus. The two chalazal nuclei have not been observed to divide further. The upper, which is the larger of the two, functions directly as the lower polar nucleus, while the lower degenerates and is usually not recognisable in the mature embryosac (Fig. 5).

While this seems to be the usual mode of development, there are exceptions. Sometimes, after the heterotypic division, the two daughter nuclei may not divide synchronously resulting

in a three-nucleate stage with two nuclei at the micropylar and one at the chalazal end (Fig. 6) or one at the micropylar end and two at the chalazal end (Fig. 7). If the undivided nucleus divides again, the embryosac would again become four-nucleate and follow the same course of development as already outlined above.

One embryosac showed four nuclei of which three were very small and grouped together in the chalazal end of the cell, while the fourth and largest nucleus occupied a more or less central position (Fig. 8). There are two possible interpretations as to the origin of this. Either all the four are megaspore nuclei of which only one is functional; or the micropylar may represent the upper nucleus of the dyad stage and the remaining three nuclei are the products of division of the lower nucleus. It is difficult to say which of these interpretations is the correct one.

Double fertilisation occurs in the usual way and one of the synergids becomes greatly hypertrophied.

The endosperm is free nuclear. There is a considerable aggregation of endosperm nuclei in the vicinity of the embryo and towards the funicular side of the ovule (Fig. 9). Here a haustorial pocket is formed which corrodes the cells of the integument.
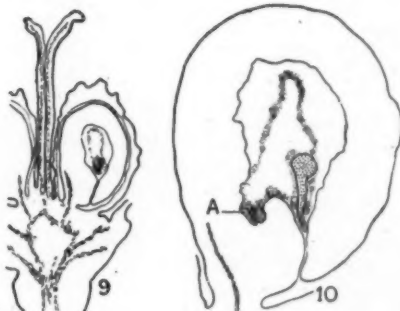
FIG. 9. L. s. carpel, ovule shows free nuclear endosperm, × 24.

FIG. 10. L. s. ovule showing haustorial endosperm-pocket marked 'A', × 48.

Although there are differences in detail, the occurrence of a tetrasporic embryo-sac and free nuclear endosperm is common to both *Flœrkea* and *Limnanthes* and confirms the opinion already expressed by several systematists that these two genera should be assigned to a separate family, Limnanthaceæ. Further investiga-

tion is, however, needed to clear up the systematic position of this family and it still remains to be seen whether it should be included in the order Sapindales (Engler-Diels, 1936) or the Geraniales (Hutchinson, 1926).

Dept. of Botany,   B. M. JOHRI.
University of Delhi,   P. MAHESHWARI.
December 22, 1950.

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INHERITANCE OF 'CRINKLED LEAF' —A NEW ABNORMAL MUTANT IN ASIATIC COTTON

THE crinkled dwarf allelomorph series[5] in New World group comprising of cr^D and cr^C in *G. barbadense* and cr^I in *G. hirsutum* and the crumpled[4] and curly leaf[3] in Asiatic cottons are instances of abnormal mutants recorded earlier. cr^D and cr^I were simple recessives to respective normal strains while cr^C behaved as a simple heterozygote in crosses with normal *barbadense*. The complementary factors C_{p_a} and C_{p_b} were responsible for Asiatic crumpled while the curly leaf *cu* in Chinese *arboreum* was a monogenic recessive. This note describes a new abnormal leaf mutant in *G. arboreum* differing from these in origin and genetical behaviour.

The mutant was first spotted as a rogue in the seventh generation of an intervarietal hybrid in *G. arboreum, viz., indicum* × *cernuum* maintained at Coimbatore. The first leaves were normal and abnormal leaf crinkles developed later from the fifth to seventh leaf presenting the characteristic appearance evidenced in Plate. The leaf abnormality appeared to arise through reduced and disco-ordinated growth of both leaf veins and lamina, thereby throwing the intervenous tissue into folds and crinkles. The leaves remained small and narrow with chlorotic patches, but otherwise the type made good growth under ideal conditions although it was very shy in yield and late in maturity.

The genetics of this abnormal leaf character were studied in crosses with four normal leaved *G. arboreum* types, viz., K.1, CST 3, *cernuum* and '439'. The inheritance was of the blending type with incomplete dominance in F_1 and yielding a ratio of 1 : 2 : 1 for nor-

Crinkled leaf mutant

mal, F_1 and 'crinkled leaf' phenotypes in F_2. The normal and 'crinkled leaf' segregates bred true in the F_3 while the intermediates proved to be heterozygous segregating like F_1. In a back-cross to the normal, the parent and F_1 phenotypes occurred in the ratio of 1 : 1. The type CST 3 which was also a green stem/ghost[2] carrying the gene $R_2{}^{es}$ gave in F_2 an independent segregation for 'crinkled leaf' and 'ghost'. The assortment of meristic character in the normal leaved X-ray induced variant[1,6] named as '439' was independent of 'crinkled leaf' character in F_2 generation.

The abnormal new mutant character 'crinkled leaf' isolated in *G. arboreum* is assigned the gene symbol cr^o.

R. BALASUBRAHMANYAM.
V. SANTHANAM.

Agricultural Col. & Res. Inst.,
Coimbatore, *November 12, 1950.*

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XANTHOMONAS CASSIAE, A NEW BACTERIAL DISEASE OF CASSIA TORA L.

A BACTERIAL leaf-spot of *Cassia tora* growing on the waste lands at Poona, Jalgaon and Baroda was noticed during September, 1948. On leaves, the pathogen produces a few, round, water-soaked spots (1 mm.) surrounded by a distinct halo. Within a fortnight after initial infection, the spots increase in size to 5 mm. with a dark-brown to sooty black centre and a pale brown margin. Outwardly the spots resemble the 'tikka' disease (*Cercospora* leaf-spot) of groundnut. Bacterial ooze in the form of shining beads or fine scales is found on the under-surface of spots. When coalescent, the spots become irregular in shape and rugose as a result of drying of bacterial exudation. Badly affected leaves become yellow and defoliated.

Under favourable conditions of humidity and temperature, side and mid-veins get infected. The infection extends to the petioles and further down to the tender stems, forming vertical streaks sometimes up to 2 in. in length. The initial grey colour of the infected petioles and stems later turns to deep brown or black. Shining gummy beads of bacterial ooze are also found on the infected stems which in advanced stages get slight to deep cracking. Round to irregular, water-soaked spots all over the pods including the edges are common. Constrictions of the pods at one or more places are invariably due to engirdling of the pod by the pathogen.

Xanthomonas cassiæ Sp. nov.

Short rod, Gram-negative, capsulated, not acid-fast, motile by a single polar flagellum, stains readily with common dyes and measures $1 \cdot 2$-$2 \cdot 1 \times 0 \cdot 8$-$1 \cdot 0 \mu$. On potato dextrose agar plates, colonies are smooth, circular with lobate margins, shining, convex, butyrous, colour pinard yellow (R), diam. $1 \cdot 2$ cm. after 7 days with striations only at the periphery; on nutrient agar plate, colonies are flat, glistening with fringed margin, colour wax yellow (R), diam. 5 mm. after 4 days; milk peptonised; litmus reduced; gelatin liquefied; casein and starch digested; acid but no gas in dextrose, lactose and sucrose; salicin, arabinose and glycerol not utilised; ammonia and hydrogen sulphide produced; nitrates not reduced; M.R. and V.P. tests negative; sodium chloride tolerant up to 3 per cent.; non-lipolytic; Loeffler's solidified blood serum liquefied in 10 days; slight to fair growth in synthetic asparagin medium; fair growth in Koser's liquid and solid citrate media; optimum temperature 27° C.; thermal death point 51° C.

The pathogen is carried through the seed of *Cassia tora*.

Plant Path. Lab.,   Y. S. KULKARNI.
Coll. of Agric., Poona,   M. K. PATEL.
July 30, 1950.   G. W. DHANDE.

LIFE-HISTORY OF MUNTINGIA CALABURA L.

Muntingia calabura L., grown in South Indian gardens, belongs to the family of Elæocarpaceæ. The only embryological work done in this family is that of Mauritzon.*

The archesporium differentiates in four places in the anther primordium. At each place it consists of a plate of 2-3 hypodermal cells. The wall of the anther becomes 5 cells thick. Out of these, the sub-epidermal layer develops into the fibrous endothecium and the innermost layer forms the tapetum which is of the secretory type. The pollen grains are spherical, smooth walled and provided with three germ pores; they are 2-nucleate at the time of shedding.

The ovules are anatropous, bitegmic and show a blunt chalazal outgrowth. The micropyle is zig-zag and formed by both the integuments. Megaspores are arranged in a linear tetrad and the chalazal one functions and forms the embryo sac according to the *Normal*-type. The antipodals persist till the time of fertilisation and the polar nuclei fuse just before fertilisation.

Unlike in other Malvales studied, the flowers in *Muntingia* blossom when the ovules are still in the stage of small primordia in which the integument initials have not yet differentiated. Pollination occurs at this stage but fertilisation takes place only after 10-15 days. A similar condition is reported in the Amentiferæ and orchids. There is a well marked transmitting tissue in the style and this runs continuous with the glandular epidermis that lines the placentæ. The entry of the pollen tube is porogamous. Endosperm is nuclear to start with but becomes cellular later. In the mature seed the nucellus is completely absorbed.

Development of the embryo conforms to the capsella-type. In the seed it is large and straight and its cells, like those of the endosperm, store starch. The cells of the outer epidermis of the inner integument become large and radially elongated and seem to help in

the nutrition of the young embryo. The structure and development of the seed coats are similar to those of other Malvales. A fuller account of the life history will appear elsewhere.

My thanks are due to Prof. A. C. Joshi and Prof. G. N. Rangaswami Ayyangar for their kind encouragement.

Dept. of Botany,   C. VENKATA RAO.
Andhra University,
Waltair, *November* 18, 1950.

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* I am thankful to Prof. P. Maheswari for this information.

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ACTIVE RELAXATION OF MAMMALIAN UNSTRIATED MUSCLE[1,2] DURING INHIBITION PRODUCED BY ADRENALINE

THE uterine horns of a virgin guinea pig are used. Those of a guinea-pig during early pregnancy are also suitable, provided only a small portion of the tube is involved; otherwise, the pregnant uterus does not respond. The animal is killed with a blow on the head and the uterine horns removed and immersed in saline at 25–$30°$ C.; they are then split longitudinally, and, if pregnant, their contents removed.

The muscles are placed in a petri dish containing saline, and adrenaline (1 in 100,000) is added. The composition of the saline was as described previously, being buffered with borate, pH $8 \cdot 1$ (Singh, 1940, 1942). The muscles begin to actively relax immediately. After about 10 minutes they begin to contract. As the tone thereafter increases, active relaxation becomes less or may even disappear if the experiment is repeated every 30 minutes. The muscle may relax up to a maximum of 40 per cent. of its initial length. The elongation is not due to contraction of the circular fibres, as there is no eversion of the split longitudinal edges; besides, substances that cause contraction do not produce any elongation.

Active relaxation may be produced by a concentration of adrenaline as low as 1 in 10 million. The optimum temperature is 25–$30°$ C. At $37°$ C., active relaxation is feeble and if the tone increases, it is absent. This action of the saline has been described previously (Singh and Singh, 1949). Substances that increase the tone, diminish or abolish active relaxation. These are lithium, ammonium, potassium, excess of calcium, strontium, barium, bromide,

iodide, nitrate, thiocyanate. Asphyxia and cyanide abolish active relaxation; this may be partially restored by glucose. Iodoacetic acid also diminishes active relaxation.

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Physiological Laboratory,
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Agra,
October 9, 1950.

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1. Singh, I., *J. Physiol.*, 1949, 98, 155; *Ind. Journal Med. Sci.*, 1942, 30, 629. 2. Singh, S. I., and Singh, I., *Curr. Sci.*, 1948, 17, 306; 1950, 19, 60; *Proc. Ind. Acad. Sci.*, 1949, 30, 343.

ON THE OCCURRENCE OF FOLIAR ASCIDIA IN *CLERODENDRON INFORTUNATUM* GAERTN.

ABNORMAL ascidia of *Clerodendron infortunatum* Gærtn. (Fam.: Verbenaceæ) were first noticed by the writer in 1939 and the variations in the leaf-form a little later.

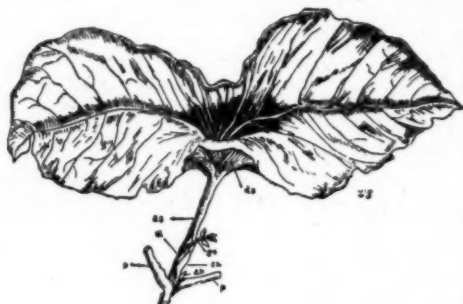The ascidium (Fig. 1) occupies the terminal apex of some shoot, being formed by the fusion

FIG. 1

Terminal ascidium of *Clerodendron infortuntum* (Nat. size). *a b*–axillary buds. *a s*–stalk of the ascidium. *d s*–dorsal side of the blades. *g s*–the terminal engulfed bud growing out into a shoot. *p*–basal parts of the opposite petioles below the terminal ascidium. *sl*–a natural slit at the base of the ascidial stalk. *s n*–swollen node from which the ascidial stalk arises. *v s*–ventral side of the blades.

of two leaves opposed to each other. Its fused stalk arises from a node bigger than the normal ones. The terminal young bud is situated at the base, and is engulfed completely by the pouch-like fused stalk of the ascidium. This engulfed bud is very poorly developed. Only in rare cases this bud develops and comes out through a natural slit at the base of the ascidial stalk (Fig. 1, *g. s.*). At first the terminal

socketed bud elongates in a displaced and inclined position but later on, the growing shoot assumes its normal vertical position and the ascidium is displaced to one side.

In the transverse section of the ascidial stalk, it is found that the outer epidermis has uniseriate hairs, the cortex is differentiated into collenchymatous and parenchymatous cells and starch sheath is detected by treating a transverse section with Chlor-Zinc-Iodine solution. Isolated thick cells in small patches of hard bast are found in the pericycle. In the transverse sections of the thicker stalks, however, these isolated patches were almost united to form a ring. Similar formation was recorded by Solereder[1] in the axis of other species of *Clerodendron* and some other genera. Crystals of calcium oxalate are abundant in the ground tissue. The vascular bundles near about the middle part of the ascidial stalk are arranged in two concentric rings which are separated from each other by several layers of broad cells of parenchyma. The vascular bundles of the petiole of the normal leaf are arranged somewhat in a kidney-shaped outline. When two such opposite petioles unite by their margins to form the ascidial stalk, the two sets of vascular bundles are rearranged and are turned into two distinct concentric rings—the outer ring being formed out of the abaxial arcs and the inner ring of the adaxial arcs of the two sets of normal vascular bundles of the opposite petioles. The vascular bundles of the outer ring are collateral, large and are separated from one another by medullary rays of varying breadth. The large vascular bundles of the thick stalk of the ascidium usually increase in diameter by secondary growth as noted by Eames and MacDaniels.[2] Compared with the vascular bundles of the outer ring, those of the inner are smaller, open collateral and inversely oriented. Slight activity of cork-cambium is found in the older stalks. Within the inner ring of the vascular bundles several layers of cells of the ground tissue are observed. There is a central cavity which is bound by the inner epidermis with cuticle and often a few uniseriate hairs (Fig. 2). Morphological and
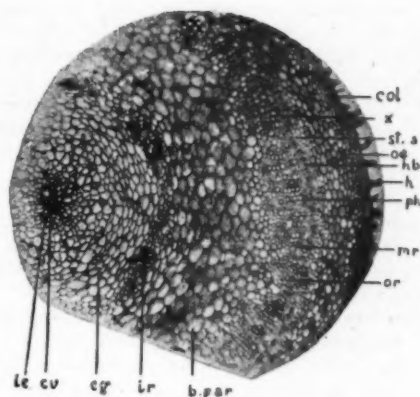

FIG. 2

Photomicrograph of a portion of a trans. sec. of the ascidial stalk of *Clerodendron infortunatum* (Eye piece 1 × Obj. 8. I. III *a*). *b. pa*—broad cells of parenchyma, separating the outer and the inner rings of vascular bundles. *cg*—cells of the ground tissue between the inner ring of vascular bundles and the inner epidermis bounding the central cavity (*c v*). *col*—collenchymatous cells of the ground tissue. *h*—epidermal hair. *h b*—patches of hard bast. *i e*—inner epidermis bounding the central cavity (*c v*) running throughout the ascidial stalk. *i r*—inner ring of inversely oriented vascular bundles. *m r*—medullary rays. *o e*—outer epidermis. *o r*—outer ring of vascular bundles. *pa*—parenchymatous cells of the ground tissue. *ph*—phloem. *st. s*—starch sheath. *x*—xylem.

anatomical analysis of the cup reveals that the inner and outer sides of the cup correspond respectively to the ventral and dorsal sides of the normal leaf.

Fuller details will be published elsewhere.

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R. G. Kar Medical College,
Calcutta-4,
August 29, 1950.

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CENTRAL BUILDING RESEARCH INSTITUTE

THE foundation-stone of the Central Building Research Institute at Roorkee, Uttar Pradesh, was laid on February 10, 1951 by the Hon'ble Mr. Sri Prakasa, Minister for Natural Resources and Scientific Research. The Institute will undertake research on building materials, on engineering and structural aspects of buildings and their foundations and on problems of residential comfort, durability of buildings and speed in their construction.

REVIEWS

High-Speed Computing Devices. By the Staff of Engineering Research Associates, Inc. (McGraw Hill), 1950. Pp. xiii + 451. Price $ 6·50.

In the words of the authors, "this volume is primarily a discussion of the mechanical devices and electrical circuits which can be incorporated into computing machines". Its contents originally formed a report prepared for the Office of Naval Research, U.S.A., on the state of development of computing machine components. The authors have therefore discussed not only methods which already exist, but also those which appear to be promising, although not sufficiently worked out at present.

The book deals with both digital and analog computers and is divided into three parts: (1) The basic elements of machine computation; (2) Computing systems; and (3) Physical components and methods. General considerations are contained in Chapters 1 and 2. The next two chapters deal with types of electronic counters, switches and gates. Then come three theoretical chapters on the functional approach to design, arithmetic systems and numerical analysis. The binary system has a number of advantages over other systems in the design of computers. Next follow three chapters on digital computing systems such as simple desk calculators, punched-card machines and large-scale electronic computers. Analog computing systems, differential analysers and harmonic analysers, etc., are discussed in a brief chapter. Part III includes a detailed discussion of arithmetic units (*e.g.*, adders and multipliers), components for storage and transfer of data and data-conversion equipment including input, output and radix-changing devices. In the end are given special techniques of possible use in automatic calculation and an outline of some of the factors affecting the choice of components.

On the whole a very comprehensive account, in which the latest information in each subject has been presented by specialists, the book is indispensable for any one who wishes to set up or use automatic computing machines. Particularly valuable is the extensive bibliography included at the end of each chapter. The presentation is highly elegant and the treatment, although quite advanced, is easy to understand and eminently practical. Scientists and statisticians have to be grateful to the authors for making their report available to a wider circle of readers.

G. N. R.

Crystals and the Polarising Microscope. By N. H. Hartshorne and A. Stuart. Second Edition. (Edward Arnold & Co.), 1950, Pp. xii + 462 and 312 Figs. Price 50 *sh*.

This second edition is a completely revised and enlarged version of the earlier edition published in 1934. The sub-title, *A Handbook for Chemists and Others*, makes it clear that the book is intended not only for the petrologist and the crystallographer but also for chemists and physicists who are finding more and more uses for the polarisation microscope in their studies. To make the latter familiar with the fundamentals of crystallography, the first four chapters deal with topics in morphology, symmetry and crystal structure, stereographic projection and a physical treatment of the propagation of light in crystals. Next follow a description of the polarising microscope and of the methods for preparing and mounting specimens. Two excellent chapters contain the techniques for the examination of crystals in parallel and convergent light respectively. The last four chapters deal with diverse topics such as the use of the universal stage, methods for identifying a crystal from its optical behaviour, liquid crystals and the study of fibres and other biological materials.

The details of the experimental techniques have been given with particular thoroughness, so that it should be possible for a student to learn them without the help of an instructor. The theoretical background is also amply covered, though mathematical details are strictly omitted. The modern Hermann-Mauguin nomenclature is used throughout for point-groups and space-groups. However, a few errors have crept into the description of these symbols. Thus, the authors have wrongly stated that the second *m* in the description *m* 3 *m* of the point-group *O* is a vertical plane of symmetry. Actually, it is a diagonal plane, parallel to (110). In Fig. 54 also, the diagonal planes are omitted. The statement, "Hence the symbol 6_1 means that the operation of such a

six-fold screw axis is equivalent to a translation of the lattice by the length of one cell" is not correct. The associated translation must be $c/6$, not c. A number of similar errors occur in pp. 59-61. These have been pointed out mainly so that they may be rectified in a future edition, but they do not detract from the excellence of the book, which will serve as a suitable text-book for students of mineralogy and a useful reference book for physicists and chemists.

G. N. RAMACHANDRAN.

An Introduction to Electronics. By J. Yarwood. (Published by Chapman & Hall, London), 1950. Pp. ix + 329. Price 28 sh. nett.

When a large number of books on Electronics already exist, the addition of this work to the number calls for an explanation. This, the author has clearly set out as the need of a book of an intermediate standard between the advanced works and the more elementary ones. Besides, in the opinion of the reviewer, the book lays special emphasis on the physical principles and sets out to give a clear picture of the subject as a physicist looks at it. Such books are not many in the field. Further, the treatment is elementary although quite complete. The exposition is very lucid. As such, the book should be most welcome to all physicists who are not familiar with this branch and to present-day students of physics and engineering as a very good introduction to the subject. The inclusion of chapters on the electron microscope and the U.H.F. tubes is very appropriate and adds considerably to the utility of the book. All types of tubes and the principles underlying their application including the cathode-ray tube and the photo-electric tube come up for treatment. Everywhere, the treatment is well balanced, clear and correct.

The printing and general get-up of the book is very good. The diagrams are well-drawn and reproduced. There is a good bibliography at the end and an index.

The reviewer may add a few suggestions and these should not be misunderstood as criticism. A book of this type goes to a student as an introduction to the vast field of electronics and electronic engineering. As such, it is necessary that there should be at the end of each chapter a few questions and more particularly a number of numerical problems with answers. The real test of a person knowing electronics is his ability to calculate and then rig up a few circuits. Another desirable feature to be included is to reproduce typical valve data as given by a manufacturer and then set out to calculate a few particulars. This need not be done everywhere, but a few typical cases will be useful. Both these features can be incorporated without adding to the bulk of the book by compressing the first four chapters on electricity and magnetism.

S. V. CHANDRASHEKHAR AIYA.

Radio Aids to Navigation. By R. A. Smith. Edited by J. A. Ratcliffe. (Published by the Cambridge University Press in the Modern Radio Technique Series), 1950. Pp. xii + 114. Price 9 sh. nett.

This little book is a most welcome addition to the available literature and both the author and the publishers are to be congratulated for producing the book. The amount of literature now available in this field is so vast that the honours student in communication engineering is at a loose end. With the limitations of time and the wide variety of subjects that such a student has to study, it is difficult to expect him to go through journals or special numbers like the *Radio Location Supplement of the I.E.E.* This book presents all the information necessary in a clear manner without going into details.

The book is mainly concerned with aids to air navigation and is divided into fifteen chapters. It deals with short range navigational aids like radar interrogators and responder beacons, D/F, V.H.F. ranges, Gee, etc., after a brief historical introduction, which brings out clearly the problems that presented themselves. This is followed by long range navigational aids like the loran, c.w. systems, etc. Radio altimeters, instrument landing, airfield control, etc., also come up for a balanced treatment. Being mainly descriptive, the book discusses in a very lucid manner each system. Although a British publication, adequate reference is made to developments that took place in Germany and the U.S.A. as in v.h.f. D/F.

The printing and get-up of the book are excellent. The diagrams and plates are well reproduced. The book is indispensable to any communication engineering or physics library.

S. V. CHANDRASHEKHAR AIYA.

Carotenoids. By Paul Karrer and Ernst Jucker, translated by E. A. Braude. (Elsevier Publishing Co., Amsterdam), 1950. Pp. x + 334. Price $ 8·50.

The carotenoids, constituting a group of yellow to red pigments, are of great interest for

a variety of reasons, among which are their relationship to vitamin A (several carotenoids being precursors of this vitamin), their wide distribution in nature (in plants as well as animals), their chemical character as polyenes and as isoprene derivatives, their light absorption characteristics, and the applications of chromatography to separations in the carotenoid field. When Palmer wrote in 1922 the first book on the carotenoids, little was known of their chemistry. Zechmeister, who has made many contributions to our knowledge of the carotenoids, particularly *cis-trans* isomerism and absorption spectra, reviewed the chemistry of the carotenoids in a book published in 1934. The present book not merely brings the material up to date, but is also a comprehensive treatise which gives a detailed, fully documented and very readable account of the carotenoids. It is well known that much of the recent work on these pigments has been carried out in Karrer's laboratories; the Swiss edition of the book appeared in 1948, and the English edition has the advantage that the translation has been made by a member of the Heilbron school which has been responsible for a long series of important papers on the chemistry of vitamin A and related polyenes.

The book is divided into two parts—general and special. The nine chapters of the general part deal with the occurrence, distribution and formation of the carotenoids in nature, isolation and estimation of the pigments, methods of determining their chemical constitution, *cis-trans* isomerism, and the synthesis of carotenoids. The individual carotenoid pigments are treated in five chapters in the special part. While the literature survey is complete and includes many hundreds of references, the material is presented with remarkable clarity. More attention might perhaps have been paid to recent work on carotenoid metabolism and the physiological activity of pro-vitamins A in relation to their stereochemistry, but otherwise, this monograph will be for many years the indispensable book for study and reference to which workers on any aspect of the carotenoids will turn. A special word of praise is necessary for the very high quality of the printing.

K. V.

Research Bulletin of the East Punjab University. Vol. I, Nos. 1, 2, 3, 4 and 6. Price Rs. 2.

The Bulletin of the East Punjab University recently published, intends to issue at least one publication on the average per month, the subjects covered being Botany, Zoology, Physics, Chemistry, Astronomy, Mathematics and Geography.

No. 1 of the Bulletin contains a paper by Messrs. Viswanath and Gurdev Kaur Gill on the Parallelism between Variations of Taxonomic Value and Cytological Resemblances in Allied Species; Nos. 2 and 3 contain a Table of Values of Liouville's Function $L(t)$ by Hansaraj Gupta; No. 4 by the same author gives a simple proof of the Prime Number Theorem based on Selberg's Formula, while No. 6 describes an Air Control Thermo-Regulator by M. L. Lakhanpal.

Considering the excellent start it has made, it is hoped that the future issues will serve to advance the development of scientific research in this country.

Muscular Contraction—A Topic in Molecular Physiology. By W. F. H. M. Mommaerts. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd.), 1950. Pp. ix + 191. Price $4·2.

The advance in this field of science is so rapid, that there is every justification for the appearance of such a booklet. It is very valuable for those who seek an introduction into this field of study and to those who must keep abreast of the present state and the latest developments of the problem. There is mention and discussion of the most recent biochemical investigation on the mechanism of contraction in striated muscle, and description of the actual experimental discoveries and their immediate interpretations. This problem has received wide and many-sided attention for several generations, the work of Meyerhof and Hill being specially significant, and more recently that of Szent-Györgyi.

The book contains fifteen chapters, devoted to qualitative and quantitative aspects of muscle metabolism, sequence of events in muscular activity, muscle proteins, muscle fibres, reaction between ATP and myosin, etc. The scope of the subject-matter is necessarily limited in a book of this size, but there is much stimulating information which should appeal to a very wide circle of readers wishing to know more about developments in these subjects. It is a pleasure to see such a book.

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Madras University Endowment Lectureships for 1951-52

Applications for Lectureships will be received by the Registrar not later than the 15th March 1951. Applicants are requested to give full particulars regarding their qualifications, etc., and the subject selected by them for the lectures. The lectures are ordinarily to be delivered before the end of January 1952.

Separate applications should be submitted for each lectureship.

The principal terms and conditions of award are given below:

1. *The Maharaja of Travancore Curzon Lectureships.*—Three lectureships of the value of Rs. 250 each, relating to: (a) Medicine—Clinical; (b) Engineering; and (c) Agriculture.

2. *The Dr. Elizabeth Matthai Lectureship—Value Rs. 300.*—A course of not less than three lectures should be delivered on a subject embodying the results of original investigations in some branch of Medicine and Surgery—preference being given to a subject having special reference to the requirements of women and children.

3. *The Dr. A. Lakshmanaswami Mudaliar Lectureship—Value Rs. 500.*—A course of not less than three lectures should be delivered at Madras on any subject pertaining to Medicine in any of the various departments including Medical Education, Medical Relief and Public Health and History of Medicine.

Ramanujam Memorial Prize, 1951

"The Ramanujam Memorial Prize" of the value of Rs. 500 will be awarded for the best essay or thesis written on any branch of Mathematics, embodying the result of the personal investigations of the author and containing clear evidence of independent and original research. The prize is open to all persons born or domiciled in India. Intending competitors should forward their essays or theses so as to reach the Registrar, University of Madras, not later than the 1st December 1951. Further details can be had from the Registrar.

International Seminar

An international seminar is being organised by the World Federation of United Nations Associations in connection with the Seventh Session of the Economic Commission for Asia and the Far East (ECAFE). The seminar will be held at Lahore (Pakistan) from February 27 to March 7, 1951, concurrently with the Commission's Session.

The object of the seminar is to make more widely known the work of the United Nations and especially of the ECAFE. The lectures at the seminar will be so arranged that those attending the seminar will also be able to attend the meetings of the Commission.

European Physics Laboratory

Offers have come from Italy and France of financial help to permit UNESCO to study the possibility of setting up a West European Physics Laboratory for High Energy Particles. The study is to be made under the direction of Prof. Pierre Auger. It is proposed that the laboratory should house a cosmotron for producing particles of enormous energy.

Sir Alexander Fleming

Sir Alexander Fleming, the well-known British scientist who discovered Penicillin, has been elected an Honorary Fellow of the National Institute of Sciences in India.

Origin and Distribution of Cultivated Plants in South Asia

The Indian Society of Genetics and Plant Breeding in collaboration with the UNESCO Office, Delhi, organised a Symposium on the above subject in Delhi from January 12 to 15. Besides participants from the countries of South Asia, Profs. Edgar Anderson (U.S.A.), S. C. Harland (U.K.) and A. Muntzing (Sweden) participated and there was a delegation of four Chinese botanists from the Academia Sinica. The complete proceedings will be published by the sponsoring Society and orders may be placed with the Secretary of the Society, C/o Division of Botany, Indian Agricultural Research Institute, New Delhi 5. A few sets of the abstracts of the papers contributed to the Symposium together with a short account of the discussions may be had from the UNESCO Office for institutions.

Facilities for Study Abroad

In order to help all those in need of information, a book entitled *Study Abroad* collecting all information about financial assistance for study and training in all foreign lands was published by UNESCO first in 1943, which is

now in its third edition listing in all 35.000 offers. This book is on sale at 6 shillings from UNESCO's official sales agents (for India, Oxford Book and Stationery Co., Scindia House, Connaught Circus, New Delhi). Any bookseller in any other country may also procure it from the nearest sales agents for publication of UNESCO.

Dr. Bharucha

Dr. F. R. Bharucha, Professor of Botany, Institute of Science, Bombay, who attended the Seventh International Botanical Congress held last July in Stockholm as a delegate of the Governments of India and Bombay, has been appointed a Delegate for India on the following International Commissions:

(a) International Commission for Applied Ecology.

(b) International Commission for Phytosociological Nomenclature.

(c) International Sub-Commission for Grassland Ecology.

These three Commissions and Sub-Commissions are under the auspices of the International Union of Biological Sciences of the UNESCO.

(d) International Sub-Commission on the Vegetation Cartography on the scale 1:1,000,000.

As a Delegate for India, Dr. Bharucha will co-ordinate the work on Grassland Ecology in India and promote work on Phytosociological basis, and call for an All-India Conference on Grassland Ecology and on Vegetation Cartography shortly.

Indian Phytopathological Society

At the Annual General Meeting of the Indian Phytopathological Society held on 3rd January, 1951, at Bangalore, the following office-bearers were elected to the Council for the current year:—

President: Dr. M. K. Patel. *Vice-President*: Dr. R. P. Asthana. *Secretary-Treasurer*: Dr. R. Prasada (1950-52). *Councillors*: North Zone— Dr. M. K. Hingorani; Mid-East Zone—Dr. P. R. Mehta; Eastern Zone—Prof. S. R. Bose; Central Zone—Dr. S. Vaheeduddin; Western Zone— Dr. M. N. Kamat; Southern Zone—Sri. T. S. Ramakrishnan.

Zoological Society of India

The following were elected as Office-bearers of the Zoological Society of India, at the Annual General Body Meeting of the Society held at Bangalore in January this year:

President: Dr. K. N. Bhal, Professor of Zoology, Lucknow University, Lucknow; *Vice-Presidents*: Dr. S. L. Hora, Director, Zoological Survey of India, Calcutta; Dr. M. A. Moghe, Principal, Amraoti College, Amraoti; *Secretary*: Dr. M. L. Roonwal, Forest Entomologist, Forest Research Institute, Dehra Dun; *Treasurer*: Dr. B. S. Chauhan, Zoological Survey of India, Calcutta; *Editor*: Dr. B. N. Chopra, Fisheries Development Adviser, Govt. of India, New Delhi; *Members*: Dr. H. S. Pruthi, Plant Protection Adviser to Govt. of India, Ministry of Agriculture, New Delhi; Dr. N. K. Panikkar, Chief Research Officer, Central Marine Fisheries Research Station, Mandapam; Dr. A. B. Misra, Professor of Zoology, Banaras Hindu University, Banaras; Dr. H. R. Mehra, Professor of Zoology, Allahabad University, Allahabad; Prof. R. V. Seshaiya, Professor of Zoology, Annamalai University, Annamalainagar; Dr. Bhaskaran Nair, Professor of Zoology, University College, Trivandrum.

ERRATA

Vol. 20, No. 1, page 14, column 1: Note on "Compressibility and Complex Formation in Electrolytes".

Line 7 : read $\bar{F}_2 - \bar{F}_0$ *instead of* $\bar{F}_2 = \bar{F}_0$
Line 11: The expression should read

as follows : $\bar{K}_2 - \bar{K}_0 = f (D, P, V) (\Sigma \nu_i z_i^2)^{3/2} C^{1/2}$

Line 16: The sentence beginning with "The consequent decrease . . . is predominant" should *read* as follows: "The consequent decrease in valence factor $(\Sigma \nu_i z_i^2)^{3/2}$, and ionic density are seen to involve a decrease in $\bar{K}_2$ actually observed, etc., ... is predominant".

The references to the Note are as follows:

1. Nayar and Pande, *Proc. Ind. Acad. Sci.*, 1948, **27A**, 285; 349. 2. Narasimhamurty, *Ibid.*, 1950, **51A**, 160. 3. Bachem, *Zeit. f. Phys.*, 1936, **101**, 541. 4. Gucker, *Chem. Rev.*, 1933, **13**, 111. 5. Glasstone and Saunders, *J. Chem. Soc.*, 1923, **123**, 2134.

Vol. 20, No. 1, page 14, coloumn 2, line 30: Note on "Polarisation of Brillouin Components in Light-Scattering in Liquids".

The sentences beginning with "The scattering . . . recent note[6]" should read as follows: "The scattering due to 't$_q$' waves is stronger of the two, and evidence for the existence of such waves has been given by me in a recent note.[6]"